



THERMO KING



CRYOGENIC TECHNOLOGY for Transport Refrigeration

**Presentation to CARB
Herman Viegas
Thermo King Corporation
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Benefits of Cryogenics



- Zero diesel emissions
- No fluorinated refrigerants
- Quiet operation
- Fewer moving parts
- Rapid temperature recovery
- Safe operation – No CO₂ gas enters cargo space





Commercialization Status



- Truck and Trailer refrigeration units are in production
- Safe and Automated Filling Technology is developed and in commercial use
- CO2 Infrastructure is developed and in commercial use





In Commercial Service



Trailer Single Temperature





In Commercial Service



Truck Single & Multi-Temperature





In Commercial Service



Truck Hybrid (provides boost to diesel powered units)





Validation of Technology



SCAQMD funded study May 99- Sept 00

- **Two trailer units operated successfully in local delivery service by In-N-Out Burger**
- **Very high reliability with very little maintenance**
- **Temperature control similar to diesel TRU**
- **Sensitive to price and availability of CO₂**

Sweden Dept of Energy Funded Study

19 cryo units monitored Spring 02 ~ Jan 03

- **CO₂ infrastructure needs further development**
- **Reduce refueling time**



Infrastructure

**15 Fill Stations currently in operation
in Europe and one in Houston**



**Public Fill Station
Gothenburg**





Cooling at Depot



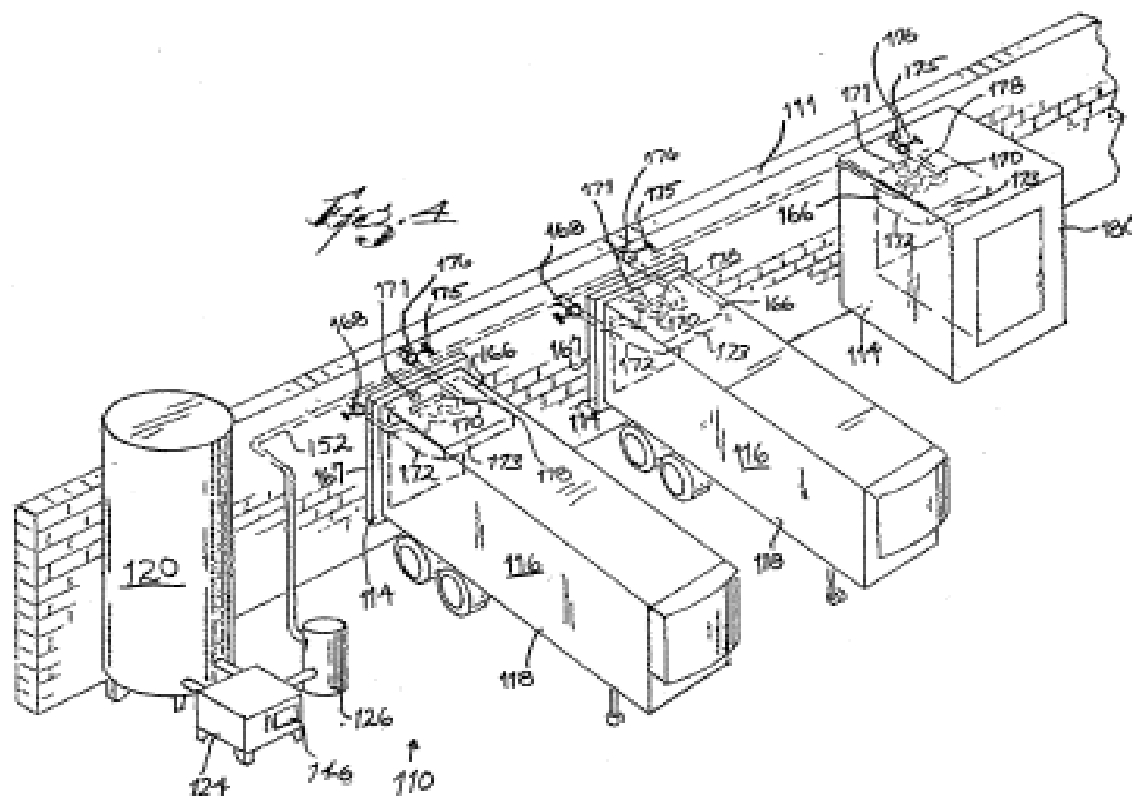
Provides environmentally friendly solution to cool truck/trailers at depots

- **No modifications needed to existing fleet**
- **Independent of the diesel TRU and vehicle State of registration**
- **No diesel emissions; No noise; Rapid pull down**
- **Minimizes operating cost - Lower cost diesel technology used over the road**



Stationary Solution

Patent Pending





Hybrid Technology



Smaller diesel reefer unit with Cryo Boost

Projected benefits [compared to diesel-only TRU]

Emission reductions (up to)

- **NO_x 47% HC 84% CO 75%**
PM 71%

Hybrid technology

- **Diesel TRU design optimized for average load**
- **Cryo system supplements the diesel TRU during peak loads**



Questions

